Mark Voorhees/R1/USEPA/US

06/24/2008 04:45 PM

To mark voorhees

cc

bcc

Subject Fw: Infiltration Rates

----- Forwarded by Mark Voorhees/R1/USEPA/US on 06/24/2008 04:45 PM -----

"Saravanapavan , Tham" <tham.saravanapavan @tetratech.com>

05/19/2008 03:15 PM

To Mark Voorhees/R1/USEPA/US@EPA

cc

Subject RE: Infiltration Rates

Hi Mark,

1. Infiltration Rates

In MD, you only can install Infiltration Basin or Infiltration Trench if the bottom soil has saturation infiltration rate of 0.52 inch/hour (Table 4.4 of MDE, 2000). The same standard is applicable if you design bioretention as an infiltration facility. Geotechnical test at individual sites are required to get the final design approval.

VA also requires minimum of 0.52 in/hr, but they also have a maximum limit 8.27 in/hr. VA requires soil boring test results for design approval. Please find attached extracts from VA manual. The original document is 18 MB. If you want, I can send you a CD or I will bring it next week.

Table 4.4 BMP Selection - Physical Feasibility

CODE	BMP LIST	SOILS	WATER TABLE	DRAINAGE AREA (Acres)	SLOPE RESTRICT.	HEAD (Ft)	ULTRA URBAN
P-1	Micropool ED	"A" Soils May Require Pond Liner "B" Soils May Require Testing	4 Feet[1] If Hotspot Or Aquifer	10 Min[2]	None	6 to 8 Ft	Not Practical
P-2	Wet Pond			25 Min[2]			
P-3	Wet ED Pond						
P-4	Multiple Pond						
P-5	Pocket Pond	OK	Below WT	5 Max[3]		4 Ft	OK
W-1	Shallow Wetland	"A" Soils May Require Liner	4 Feet[1] If Hotspot Or Aquifer	25 Min	None	3 to 5 Ft	Not Practical
W-2	ED Wetland						
W-3	Pond/Wetland						
W-4	Pocket Wetland	OK	Below WT	5 Max		2 To 3 Ft	Depends
I-1	Infiltration Trench	$f \geq 0.52$ Inch/Hr	4 Feet[1]	5 Max	Installed in No More Than 15% Slopes	1 Ft	Depends
I-2	Infiltration Basin			10 Max		3 Ft	Not Practical
F-1	Surface Sand Filter	OK	2 Feet	10 Max [3]	None	5 Ft	Depends
F-2	Underground SF			2 Max [3]		5 to 7ft	OK
F-3	Perimeter SF			2 Max [3]		2 to 3 Ft	
F-4	Organic Filter			5 Max[3]		2 to 4 Ft	
F-5	Pocket SF			5 Max [3]		2 to 5 Ft	
F-6	Bioretention	Made Soil				5 Ft	
O-1	Dry Swale	Made Soil	2 Feet	5 Max	4% Max Cross-slope	3 to 5 Ft	Not Practical
O-2	Wet Swale	OK	Below WT	5 Max		1 Ft	

Notes: OK= not restricted, WT= water table

1 **Four foot separation distance is maintained to the seasonally high water table (2 feet on Lower Eastern Shore).**

2 **Unless adequate water balance and anti-clogging device installed**

3 **Drainage area can be larger in some instances**

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STORM WATER MANAGEMENT MODEL, VERSION 4:

USER'S MANUAL

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Infiltration* --

Options--Infiltration from pervious areas may be computed by either the Horton (1933, 1940) or Green-Ampt (1911) equations described below. A complete description of the theoretical background and programming details for both is given in Appendix V. In SWMM, the method to be used for all subcatchments is determined by the input parameter INFILM (group B1). Parameters required by the two methods are quite different.

Horton Infiltration--Infiltration capacity as a function of time is given by Horton (1933, 1940) as

$$f_p = f_c + (f_o - f_c)\, e^{-kt} \qquad (4\text{-}18)$$

where f_p = infiltration capacity into soil, ft/sec,
f_c = minimum or ultimate value of f_p (WLMIN, ft/sec,
f_o = maximum or initial value of f_p (WLMAX), ft/sec,
t = time from beginning of storm, sec, and
k = decay coefficient (DECAY), sec^{-1}.

This equation describes the familiar exponential decay of infiltration capacity evident during heavy storms. However, the program does not use equation 4-18 directly; rather, the integrated form is used in order to avoid an unwarranted reduction in f_p during periods of light rainfall. Details are given in Appendix V.

Required parameters for data group H1 are f_o (WLMAX), f_c (WLMIN) and k (DECAY). In addition a parameter used to regenerate infiltration capacity (REGEN, group B2) is required for continuous simulation. Although the Horton infiltration equation is probably the best-known of the several infiltration equations available, there is little to help the user select values of parameters f_o and k for a particular application, (fortunately, some guidance can be found for the value of f_c). Since the actual values of f_o and k (and often f_m) depend on the soil, vegetation, and initial moisture content, ideally these parameters should be estimated using results from field infiltrometer tests for a number of sites of the watershed and for a number of antecedent wetness conditions. If it is not possible to use field data to find estimates of f_o, f_c, k and for each subcatchment, the following guidelines should be helpful.

The U.S. Soil Conservation Service (SCS) has classified most soils into Hydrologic Soil Groups, A, B, C, and D, dependent on their limiting infiltration capacities, f_c. (Well drained, sandy soils are "A"; poorly drained, clayey soils are "D.") A listing of the groupings for more than 4000 soil types can be found in the SCS Hydrology Handbook (1972, pp. 7.6-7.26); a similar listing is also given in the Handbook of Applied Hydrology (Ogrosky and Mockus, 1964, pp. 21.12-21.25), but the former reference also gives alternative groupings for some soil types depending on the degree of drainage of the subsoil. The soil type itself may be found in the U.S. from county SCS Soil

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*The infiltration section was prepared by Dr. Russell G. Mein, Monash University, Clayton, Victoria, Australia.

Survey maps.

The best source of information about a particular soil type is a publication entitled "Soil Survey Interpretations" available from a local SCS office in the U.S. Information on the soil profile, the soil properties, its suitability for a variety of uses, its erosion and crop yield potential, and other data is included on the sheet provided. A copy of the listing for Conestoga silt loam is shown in Figure 4-19. Parameter f_c is essentially equal to the saturated hydraulic conductivity, K_s, which is called "permeability" on the soil survey interpretation sheet. For Conestoga Silt Loam, a range of 0.63-2.0 in/hr (16-51 mm/hr) is shown.

Alternatively, values for f_c according to Musgrave (1955) are given in Table 4-7. To help select a value within the range given for each soil group, the user should consider the texture of the layer of least hydraulic conductivity in the profile. Depending on whether that layer is sand, loam, or clay, the f_c value should be chosen near the top, middle, and bottom of the range respectively. For example, the data sheet for Conestoga silt loam identifies it as being in Hydrology Group B which puts the estimate of f_c into the range of 0.15-0.30 in/hr (3.8-7.6 mm/hr), much lower than the K_s value discussed above. Examination of the texture of the layers in the soil profile indicates that they are silty in nature, suggesting that the estimate of the f_c value should be in the low end of the range, say 0.15-0.20 in/hr (3.8-5.1 mm/hr). A sensitivity test on the f_c value will indicate the importance of this parameter to the overall result.

Table 4-7. Values of f_c for Hydrologic Soil Groups (Musgrave, 1955)

Hydrologic Soil Group	f_c (in/hr)
A	0.45 - 0.30
B	0.30 - 0.15
C	0.15 - 0.05
D	0.05 - 0

Caution should be used in applying values from Table 4-7 to sandy soils (group A) since reported K_s values are often much higher. For instance, sandy soils in Florida have K_s values from 7 to 18 in/hr (180-450 mm/hr) (Carlisle et al., 1981). Unless the water table rises to the surface, ultimate infiltration capacity will be very high, and rainfall rates will almost always be less than f_c, leading to little or no overland flow from such soils.

For any field infiltration test the rate of decrease (or "decay") of infiltration capacity, k, from the initial value, f_o, depends on the initial moisture content. Thus the k value determined for the same soil will vary from test to test.

P8
URBAN CATCHMENT MODEL

USER'S MANUAL

Version 1.1

Prepared For:

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INFILTRATION RATE - LOOKUP TABLE

Need to review set of inf. rates. → check MD. → Ask Them.

References	Infiltration Rates (in/hr) (a)	(b)		(a)	(c)
SOIL TEXTURE			**SCS SOIL GROUP**		
Sand*	4.64	8.27	A	.43	.30-.45
Loamy Sand*	1.18	2.41	B	.26	.15-.30
Sandy Loam*	.43	1.02	C	.13	.05-.15
Silt Loam	.26	.27	D	.03	.00-.05
Loam	.13	.52			
Sandy Clay Loam	.06	.17			
Clay Loam	.04	.09			
Silty Clay Loam	.04	.06			
Sandy Clay	.03	.05			
Silty Clay	.02	.04			
Clay	.01	.02			

SCS "Soil Survey Interpretations" provide data on infiltration rate (permeability) for specific soils.

* Yousef et al., (1986) recommend using infiltration rate of ~ 1 in/hr for designing retention basins in sandy and sandy loam soils.

MANNING'S N - LOOKUP TABLE

Cover Type	Manning's N	Source
Light Turf	.20	a
Dense Turf	.35	a
Forest w/Dense Undergrowth	.80	a
Dense Growth	.40-.50	d
Pasture	.30-.40	d
Lawns	.20-.30	d
Bluegrass Sod	.20-.50	d
Shortgrass Prairie	.10-.20	d
Sparse Vegetation	.05-.03	d
Bare Clay-Loam Soil	.01-.03	d

Sources: a - McCuen (1982); b - Shaver (1986); c - Musgrave (1985); d - Bedient and Huber (1988)

Virginia Stormwater Management Handbook

First Edition
1999

VOLUME I

Virginia Department of Conservation and Recreation
Division of Soil and Water Conservation

Here is some information from VA Manual.

1. **Soil permeability**

The soil types within the subsoil profile, extending a minimum of 3 feet below the bottom of the facility, should be identified to verify the ***infiltration rate*** or ***permeability*** of the soil. The infiltration rate, or permeability, measured in inches per hour, is the rate at which water passes through the soil profile during saturated conditions. Minimum and maximum infiltration rates establish the suitability of various soil textural classes for infiltration. Each soil texture and corresponding hydrologic properties within the soil profile are identified through analysis of a gradation test of the soil boring material. **Soil textures acceptable for use with infiltration systems include those with infiltration rates between 0.52 inches per hour and 8.27inches per hour, and include loam, sandy loam, and loamy sand.**

TABLE 3.10 - 2
Hydrologic Soil Properties Classified by Soil Texture

Texture Class	Effective Water Capacity (C_w) (inch per inch)	Minimum Infiltration Rate (f) (inch per hour)	Hydrologic Soil Grouping
Sand	0.35	8.27	A
Loamy Sand	0.31	2.41	A
Sandy Loam	0.25	1.02	B
Loam	0.19	0.52	B
Silt Loam	0.17	0.27	C
Sandy Clay Loam	0.14	0.17	C
Clay Loam	0.14	0.09	D
Silty Clay Loam	0.11	0.06	D
Sandy Clay	0.09	0.05	D
Silty Clay	0.09	0.04	D
Clay	0.08	0.02	D

From: "Saravanapavan
To: Mark Voorhees/R1/USEPA/US@EPA

Date: Friday, May 09, 2008 10:30AM
Subject: Infiltration Rates

Hi Mark,

Please find attached an EPA document on HSPF to give ranges for infiltration rates (page 10). The following table (found in many text books) shows the minimum infiltration rate.

A	0.30 - 0.45 in/hr
B	0.15 - 0.30 in/hr
C	0.05 - 0.15 in/hr
D	0 - 0.05 in/hr

I would like to stick with EPA table if it is possible.

Thanks
Tham

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Standards and Specifications for INFILTRATION Practices

STATE OF MARYLAND

DEPARTMENT OF THE ENVIRONMENT

STORMWATER MANAGEMENT ADMINISTRATION

SEDIMENT & STORMWATER DIVISION

MARYLAND STANDARDS AND SPECIFICATIONS

FOR

STORMWATER MANAGEMENT

INFILTRATION PRACTICES

Sediment & Stormwater Division
Stormwater Management Administration
Maryland Department of the Environment
Tawes State Office Building
Annapolis, MD 21401

February, 1984

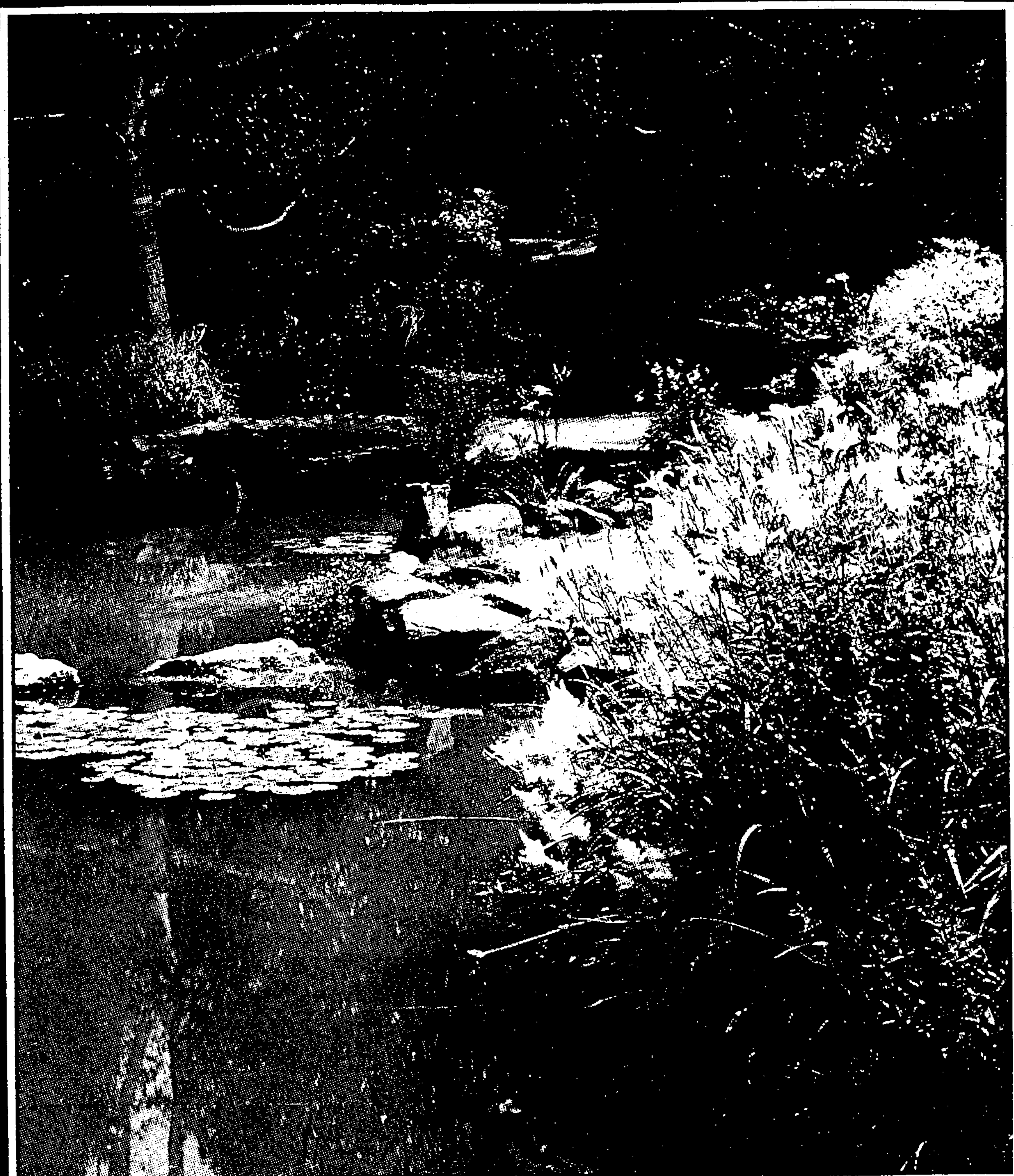
TABLE 2-1. HYDROLOGIC SOIL PROPERTIES CLASSIFIED BY SOIL TEXTURE*

Texture Class	Effective Water Capacity (C_w) (inch per inch)	Minimum Infiltration Rate (f) (inches per hour)	Hydrologic Soil Grouping
Sand	0.35	8.27	A
Loamy Sand	0.31	2.41	A
Sandy Loam	0.25	1.02	B
Loam	0.19	.52	B
Silt Loam	0.17	.27	C
Sandy Clay Loam	0.14	.17	C
Clay Loam	0.14	.09	D
Silty Clay Loam	0.11	.06	D
Sandy Clay	0.09	.05	D
Silty Clay	0.09	.04	D
Clay	0.08	.02	D

* Source: Rawls, Brakensiek and Saxton, 1982

CONTROLLING URBAN RUNOFF:

A PRACTICAL MANUAL FOR PLANNING AND DESIGNING URBAN BMPs



THIRTY 1957 1987 YEARS

Department of Environmental Programs

METROPOLITAN WASHINGTON COUNCIL OF GOVERNMENTS

Depth to Seasonally High Water Table

A minimum of two to four feet of clearance is needed from the bottom of the stone reservoir to the seasonally high water table. This is readily determined by soil borings taken during a wet period.

Proximity of Wells and Foundations

Trenches in commercial and industrial areas should be located at least 100 feet away from a drinking water well to minimize the possibility of groundwater contamination, and should be situated at least 10 feet down-gradient and 100 feet up-gradient from building foundations.

Maximum Depth of Reservoir

To insure that the stone reservoir completely drains in 72 hours, it may be necessary to limit the depth of the stone reservoir when underlying soils have relatively low exfiltration rates. These limits are shown for various soil textures in Table 5.3. If necessary, the dimensions of an infiltration trench would have to be modified in order to accommodate the necessary volume without exceeding the maximum depth limits.

Table 5.3: Soil Limitations For Infiltration Trenches

SOIL TEXTURE	MINIMUM INFILTRATION RATE (fc-inches/hour)	SCS SOIL GROUP	MAXIMUM DEPTH OF TRENCH (in) 48 hours	72 hours
Sand	8.27	A	992	1489
Loamy Sand	2.41	A	290	434
Sandy Loam	1.02	B	122	183
Loam	0.52	B	62	93
Silt Loam	0.27	C	32	49
Sandy Clay Loam	0.17	C	20	31
Clay Loam	0.09	D	11	16
Silty Clay Loam	0.06	D	7	11
Sandy Clay	0.05	D	6	9
Silty Clay	0.04	D	6	7
Clay	0.02	D	2	4

Sources: Maryland WRA (1984) and Shaver (1986).